

SUIT/Aditya-L1: A New Perspective On Solar Atmospheric Dynamics & Sun-Earth Connections

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Aditya-L1

India's first multi-wavelength space solar observatory.

ISRO: 4th to reach Sun-Earth L1 point.

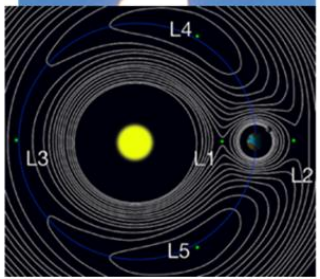
Launch: Sep 02, 2023

SDSC-SHAR, Sriharikota

PSLV-XL



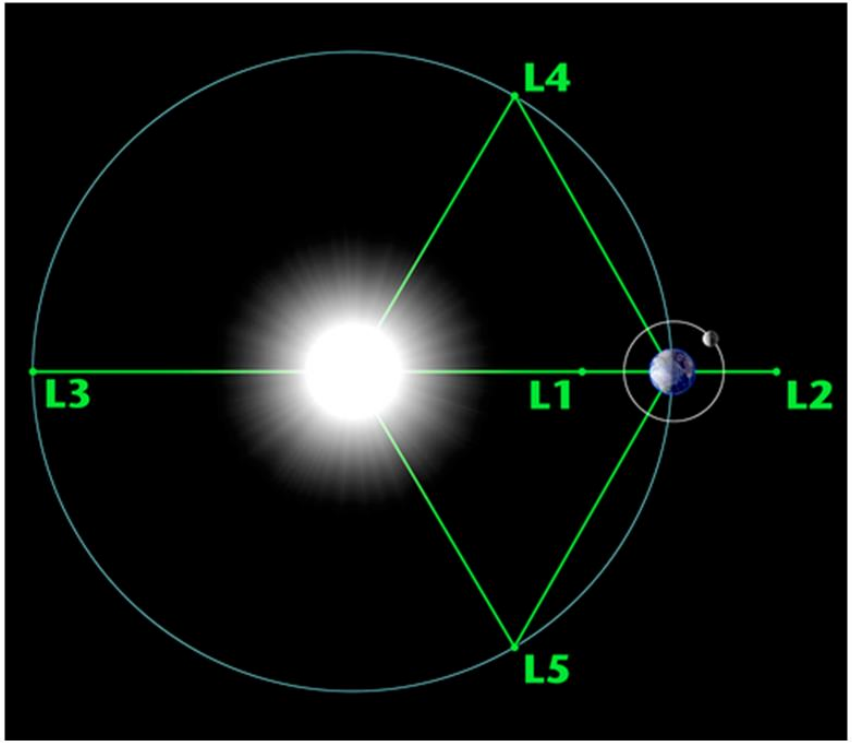






L1

ADITYA-L1 reached the L1 point on 6th January 2024



Payloads

Telescopes-

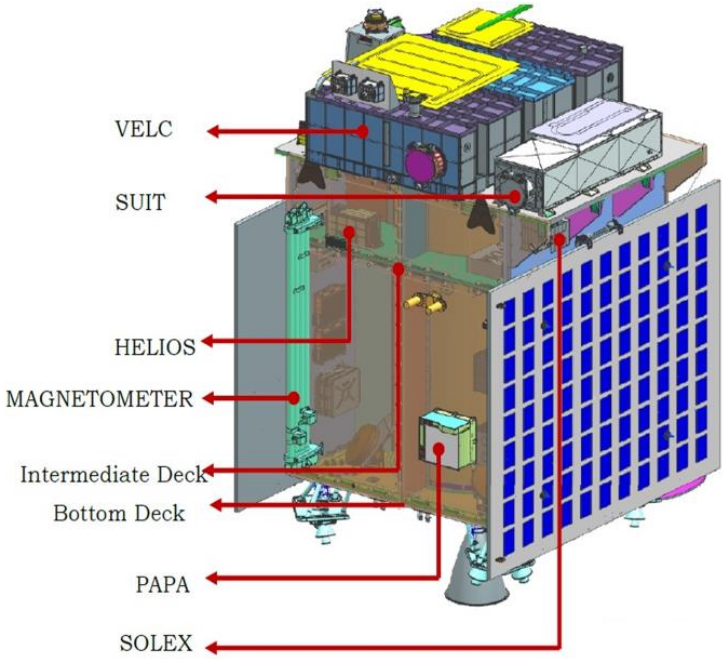
- **Visible Emission Line Coronagraph (VELC)**
- **Solar Ultraviolet Imaging Telescope (SUIT)**

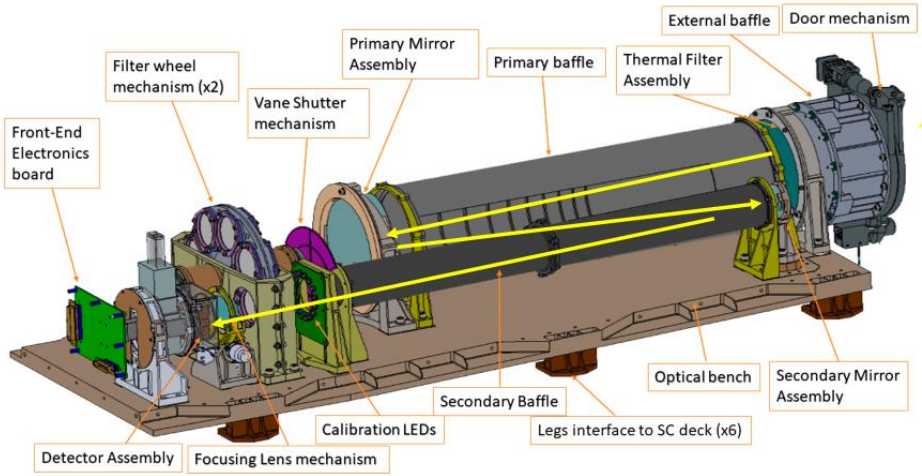
X-ray Spectrometers-

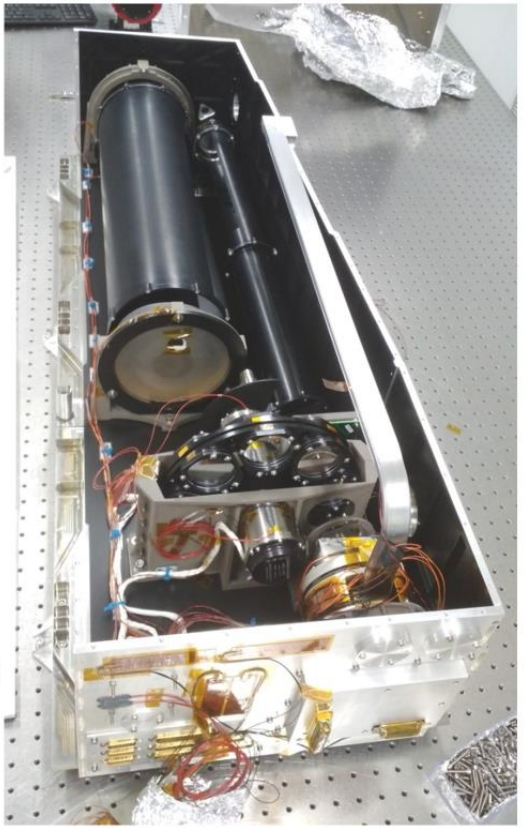
- **Solar Low Energy X-ray Spectrometer (SoLEXS)**
- **High Energy L1 Orbiting X-ray Spectrometer (HEL1OS)**

In-situ detectors-

- **Aditya Solar wind Particle Experiment (ASPEx)**
- **Plasma Analyser Package for Aditya (PAPA)**
- **Magnetometer**





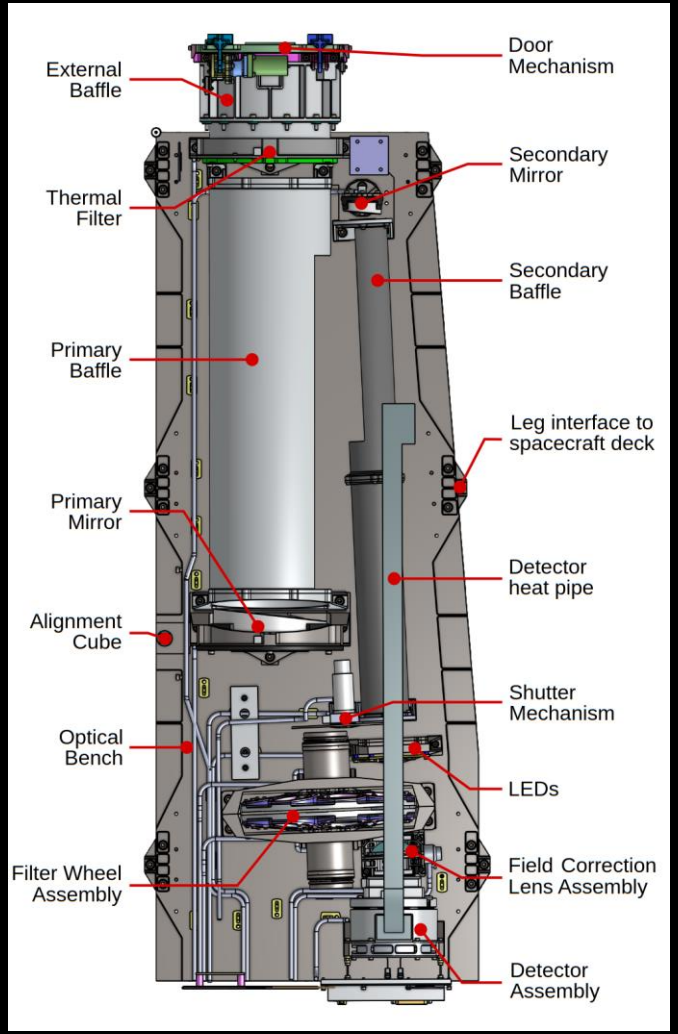


Optics:

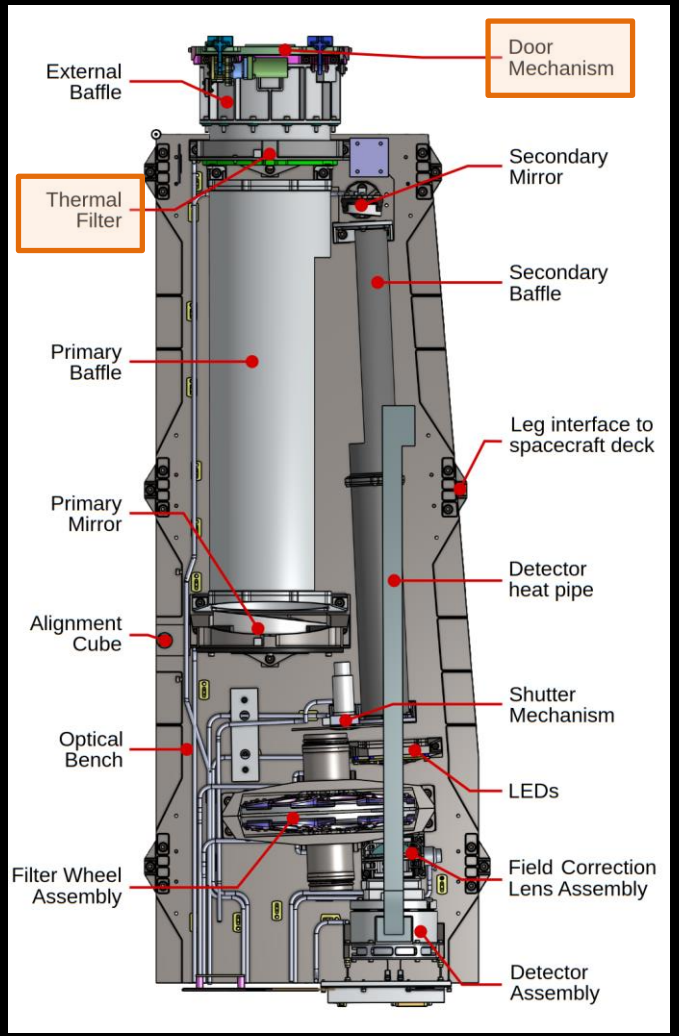
- Off Axis Ritchey Chrétien
- 146mm clear aperture @ f/24.8
- Off axis field corrector lens
- 80% encircled energy in 2x2 px

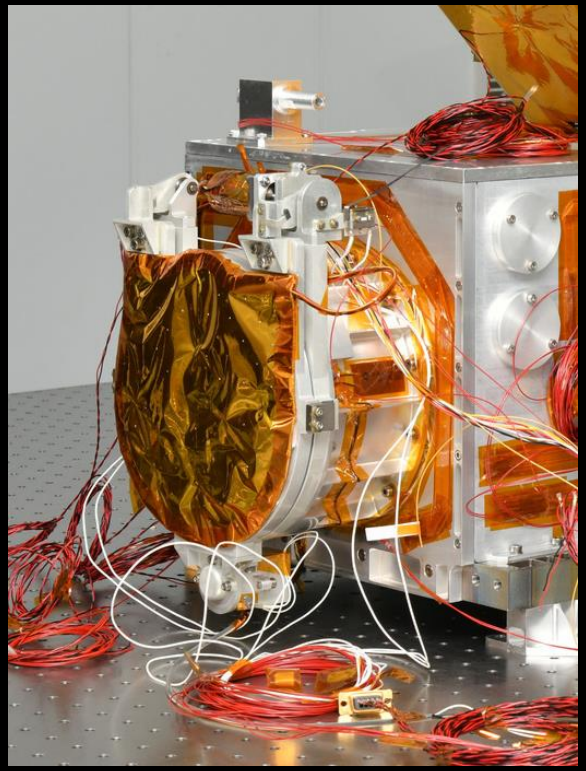
Imaging:

- Teledyne e2V back illuminated CCD
- 4096 x 4096 px, 12µm
- 0.7”/px | 1.4” angular resolution
- 0.8x0.8 deg FOV



Parts of SUIT

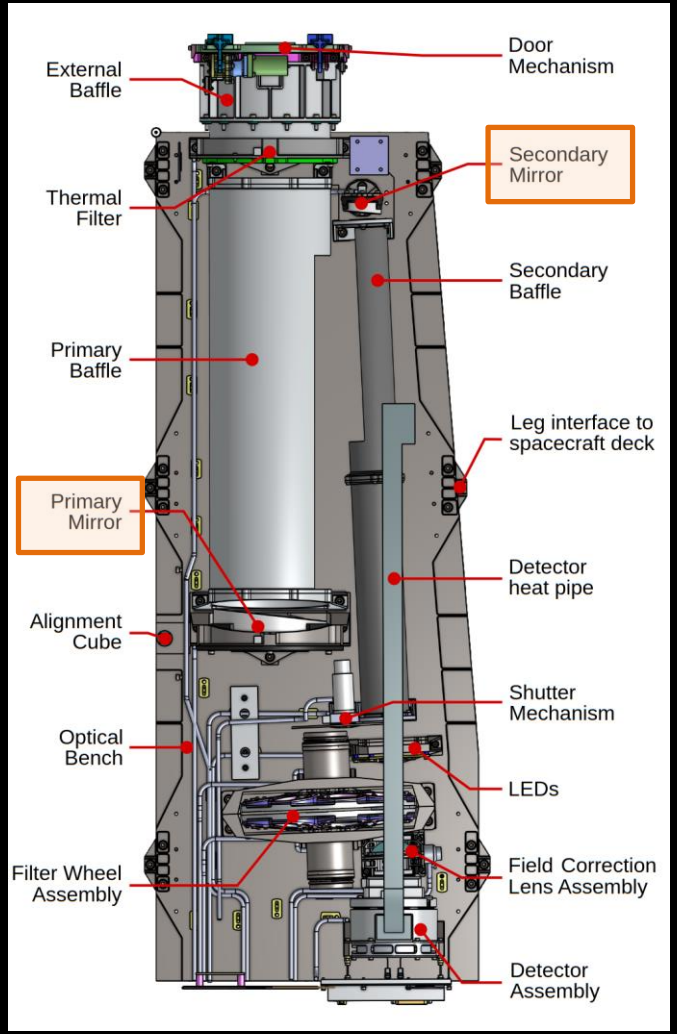




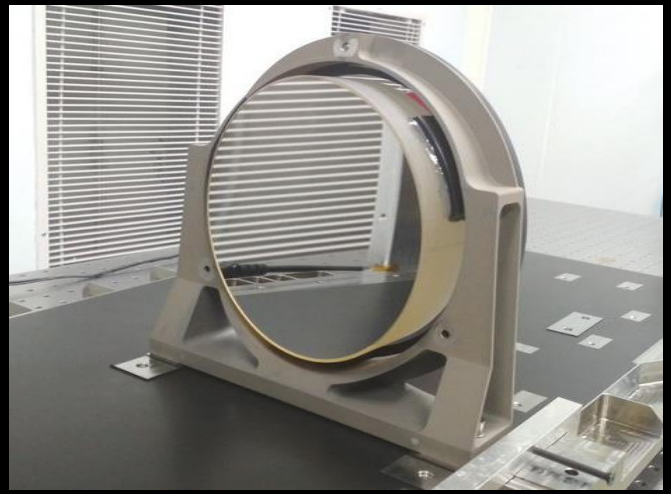
Door Mechanism

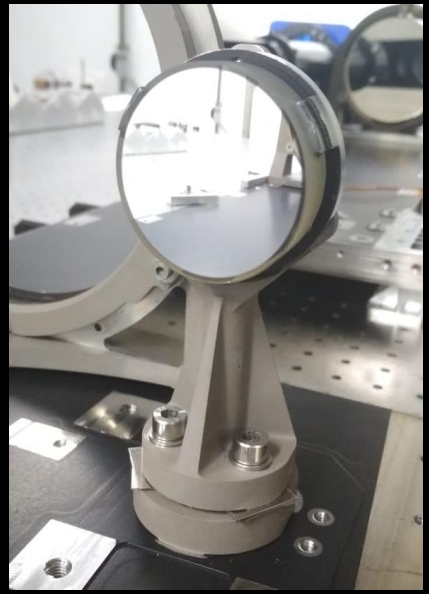
Thermal Filter



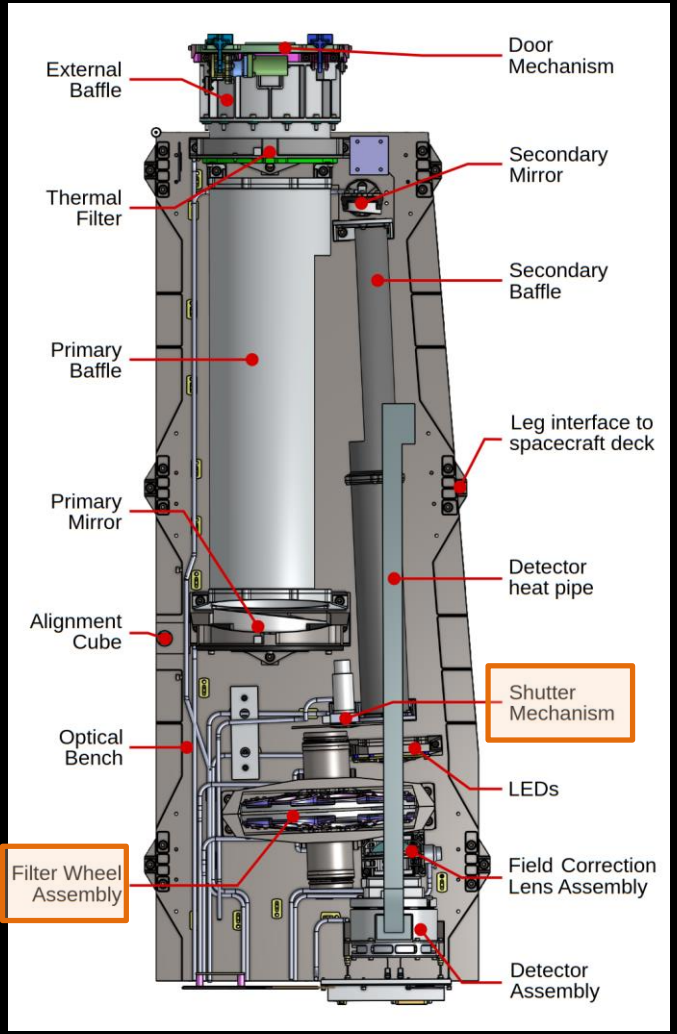


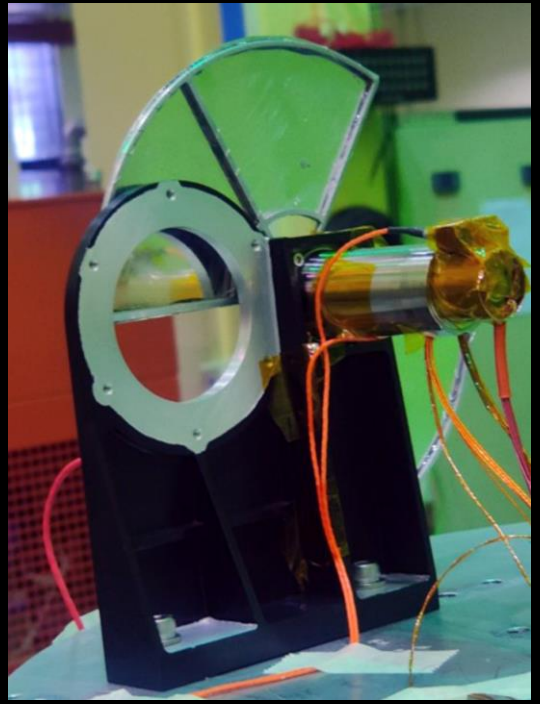
Primary Mirror





Secondary Mirror

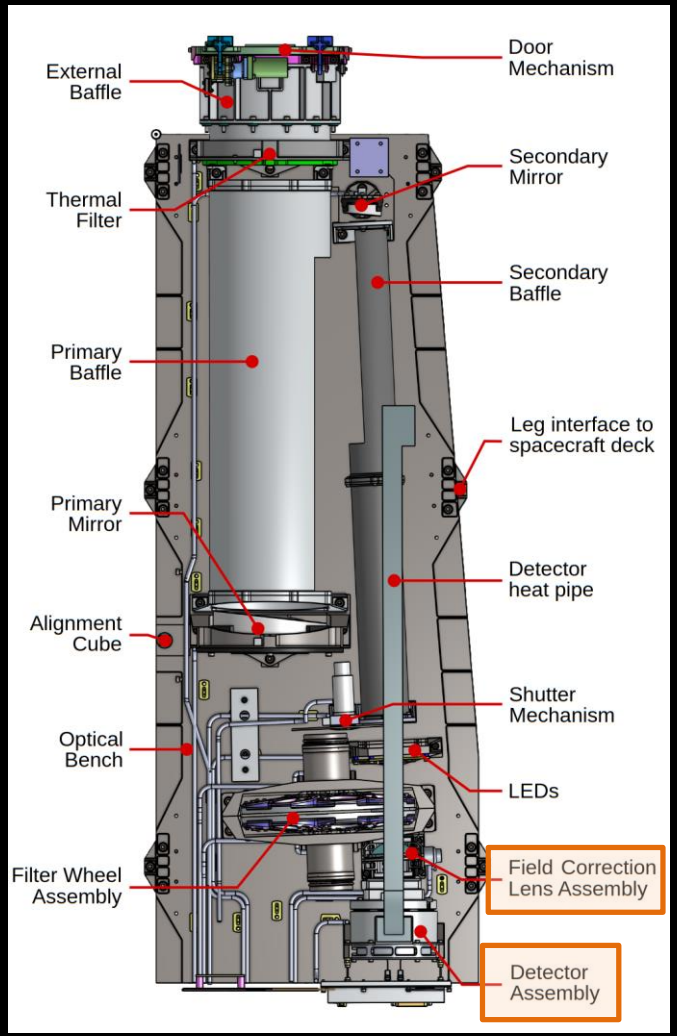


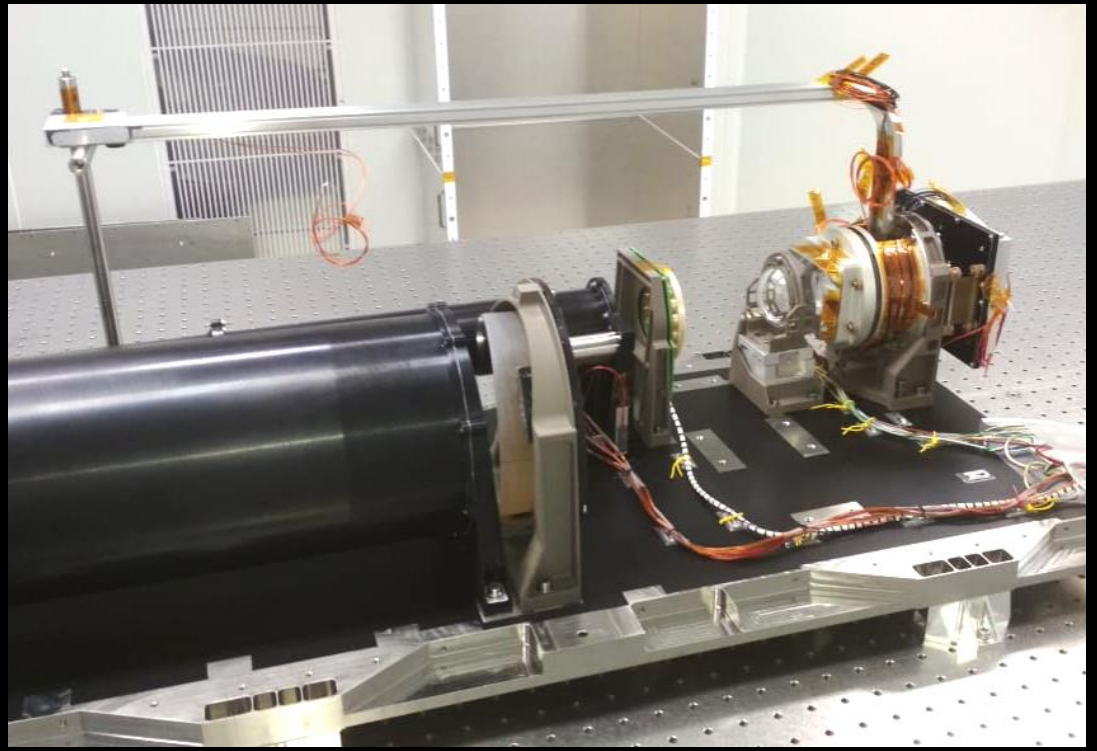


Shutter Mechanism

Filter Wheel Assembly







Detector Housing Assembly and Field Corrector Lens Assembly

SUIT

- The Solar Ultraviolet Imaging Telescope (SUIT) is an off-axis Ritchey-Chr´etien type telescope
- Focal length of 3500 mm at f/24.8, facilitated by off-axis hyperbolic primary and secondary mirrors.
- Imaging is performed on a backthinned, back-illuminated, UV-enhanced CCD.
- The CCD is a square array of 4096 × 4096 pixels, each 12 µm size. This gives SUIT a plate scale of 0.7′′/pixel and a field of view of 0.8 ◦ ×0.8 ◦ , corresponding to 1.5 R⊙.
- The instrument is designed to deliver a spatial resolution of 1.2′′making it capable of resolving structures of the order 10^3 km on the solar surface

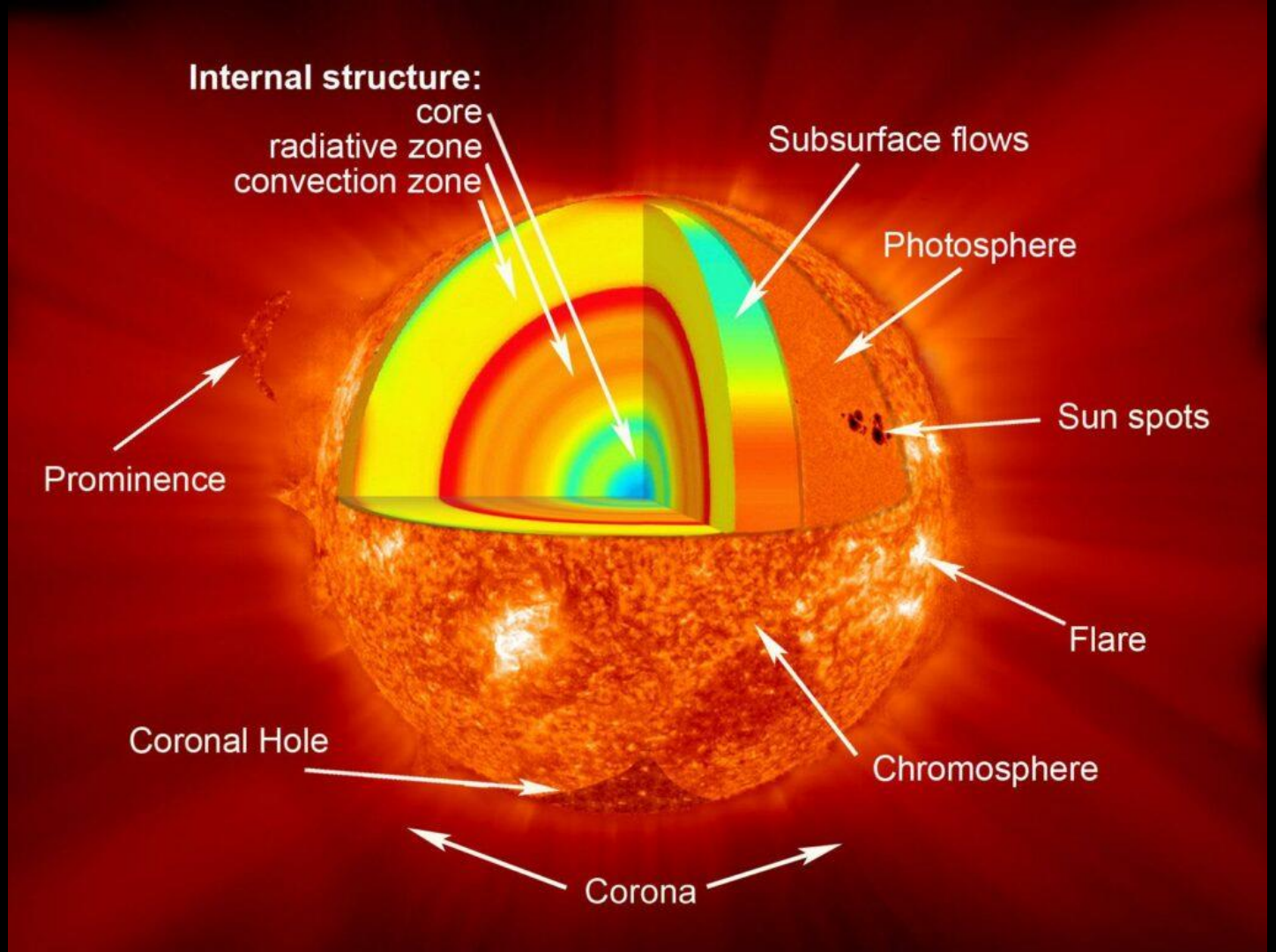
Parameter	Value
Telescope	
Design	f/24.8 two mirror off-axis design
Entrance Aperture	146 mm
Primary mirror diameter	140.8 mm
Focal Length	3500 mm
Detector	
Type	4096 × 4096, back-thinned, back-illuminated, UV-enhanced CCD
Full-well capacity	195,000 e^-
Plate Scale	0.7 arcsecond/pixel @ 12 μm pixel
Field of View (FOV)	2860× 2860 $arcsecond^2$
Cadence	
Full Frame	20 s
Region of Interest (RoI)	4 s
Filters	
Entrance aperture	blocking (out band)
Science filters	8 Narrow-band, 3 Broad-band
Exposure times	0.1 to 1.4 s
Mass	42 Kg
Power	35 W
Daily Data Volume	42 GB, uncompressed
Compression	Factor of 2, Lossless

SUIT Science Filters

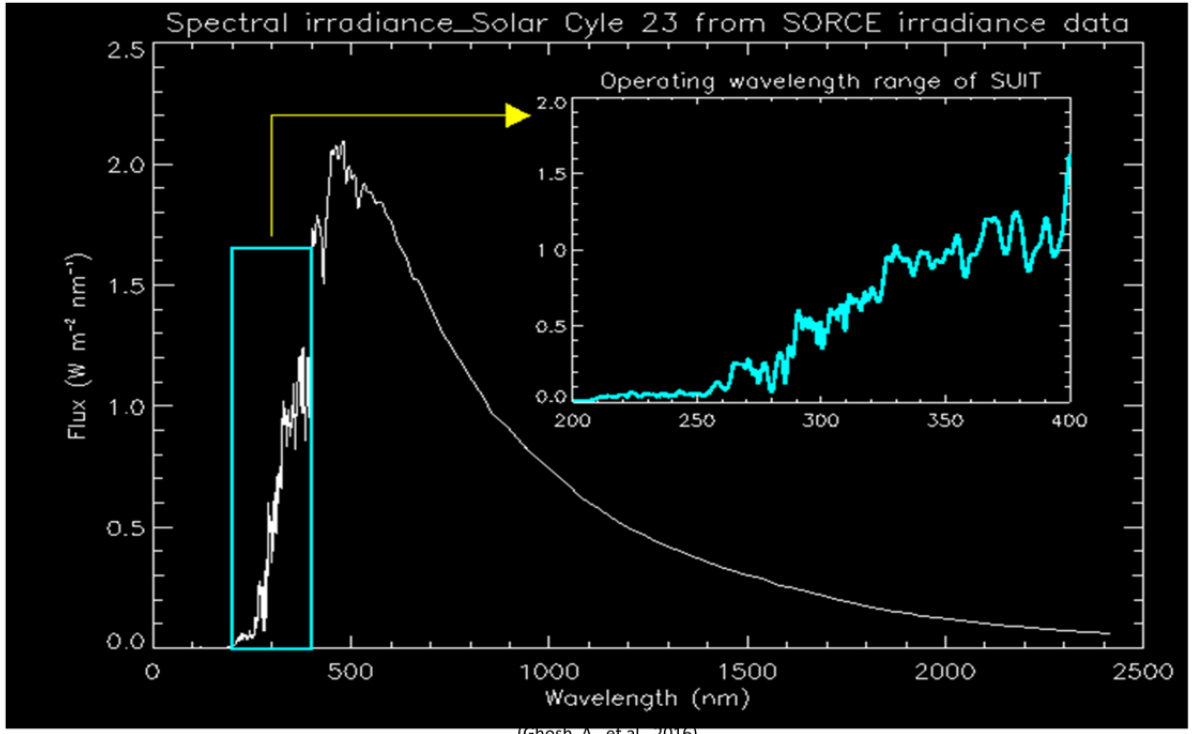




Spectral Channel (nm)	Solar Feature	Bandpass (nm)
214 (NB1)	Upper Atmosphere	11.55
276.6 (NB2)	Wing of MgII K line	≈0.5
279.6 (NB3)	MgII k line	≈0.5
280.3 (NB4)	MgII h line	≈0.5
283.2 (NB5)	Wing of MgII h line	≈0.5
300 (NB6)	Sunspots	1.5
388 (NB7)	Lower Photosphere	1.5
396.85 (NB8)	Ca II line	0.3
200-242 (BB1)	Continuum	40
242-300 (BB2)	O_3 Hartley Band	58
320-360 (BB3)	O_3 Hartley-Huggins Band	40


Internal structure:
core
radiative zone
convection zone
Subsurface flows
Photosphere
Sun spots
Prominence
Flare
Coronal Hole
Chromosphere
Corona

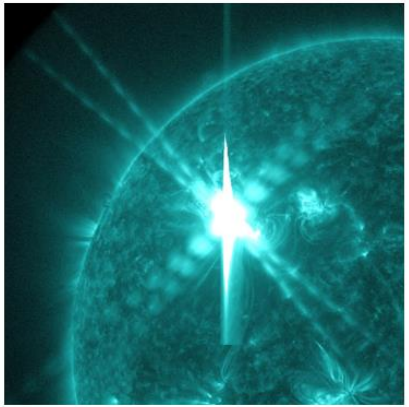
What SUIT has to offer?

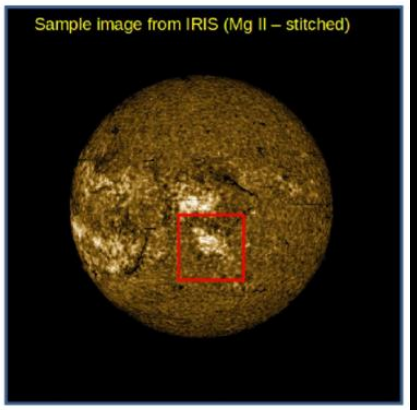


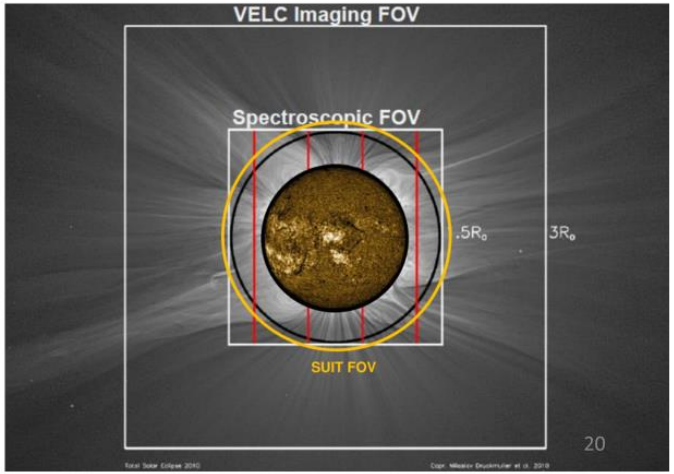
(Ghosh, A., et al., 2016)

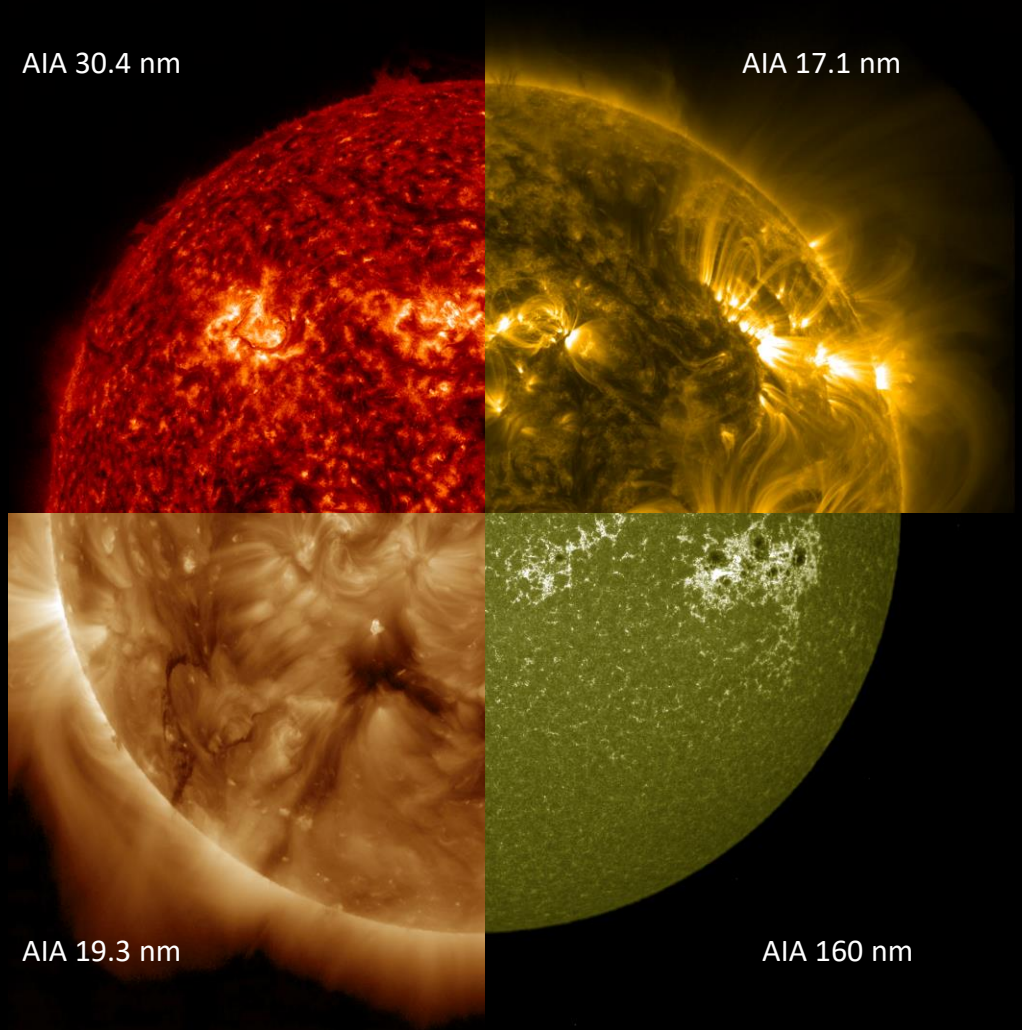
Special Features

- Automatic detection of solar flares- with help from SoLEXS and HEL1OS.
- Auto exposure control.
- High speed Region of Interest (RoI) imaging.
- Tracking solar features with Sun's rotation.
- Data combination with VELC to create wide area photos of the Sun.

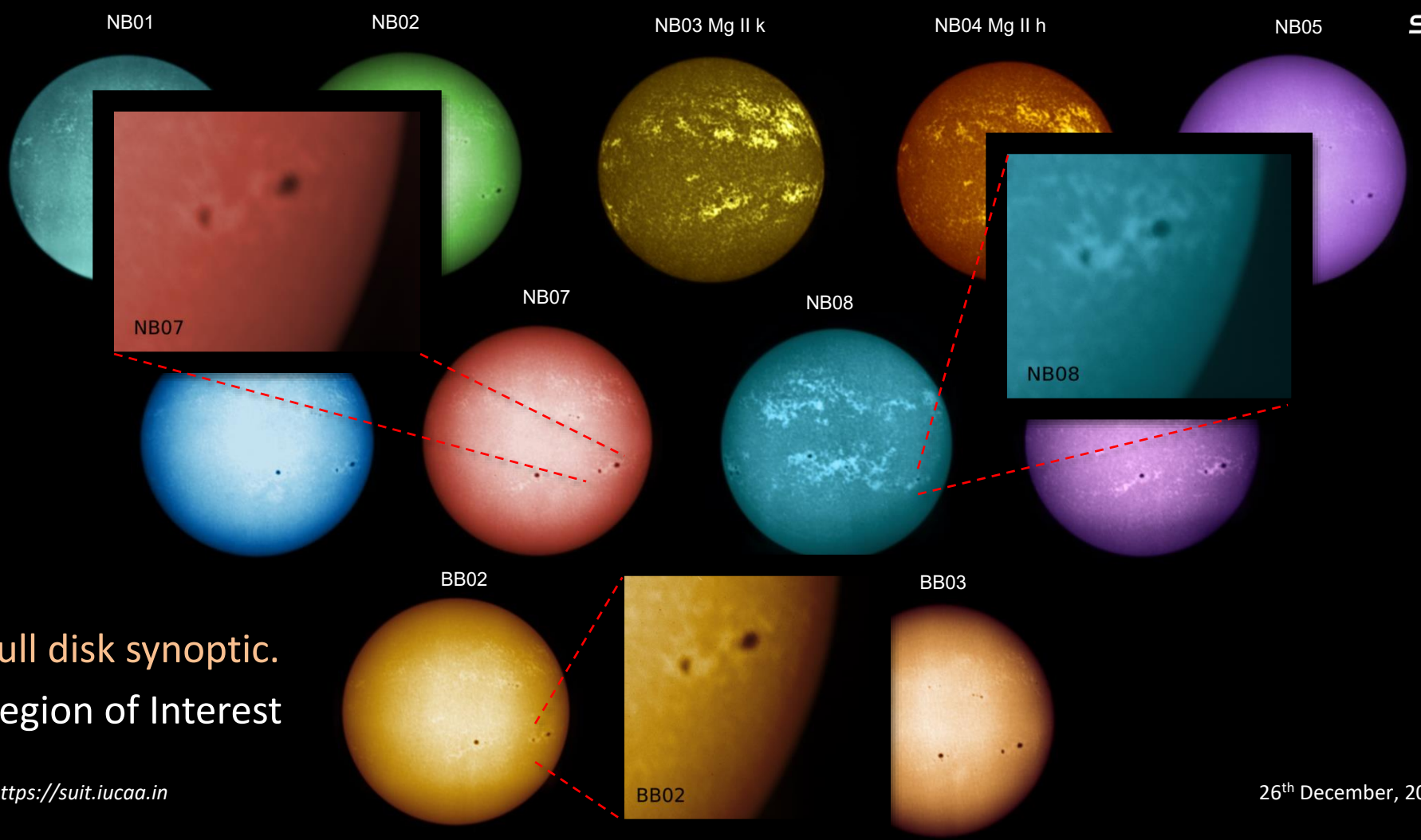








- Popular Chromospheric Observations
  - Ha (656 nm), Ca H & K (396.8 nm & 393.4 nm).
- Mg abundance~ 18x Ca in chromosphere (Asplund et al. 2009)
- Mg II k & h line formation height is higher than Ca H & K (Leenaarts et al. 2013)
- Mg II indices: Indicator for Chromospheric activity.
- Mg II k & h (279.6 nm and 280.3 nm)



Full disk synoptic.

Region of Interest

https://suit.iucaa.in

26th December, 2023

Data Pipeline

Binary files received at ISRO

SUIT POC

Documentation and L1 to L2 conversion tools will be provided at *suit.iucaa.in*

Level 0 (FITS files)

NOT available to the public

Unprocessed.

From binary stream to FITS

Level 1 (FITS files)

Available within 24 hrs at ISSDC

Processing:

- Bias and Gain.
- Scattered light and Ghost.
- Flat field and PRNU.
- Sun center and radius finding.
- WCS

Quick look images.

Level 2 (FITS files)

Available within 7 days at ISSDC

Processing:

- Dust and Spike removal
- Distortion correction
- Deconvolution

Outreach Products

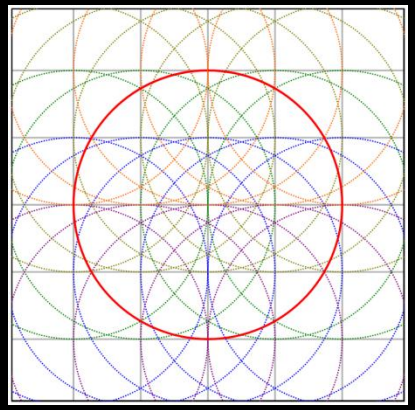
Available within 7 days at ISSDC

Processing:

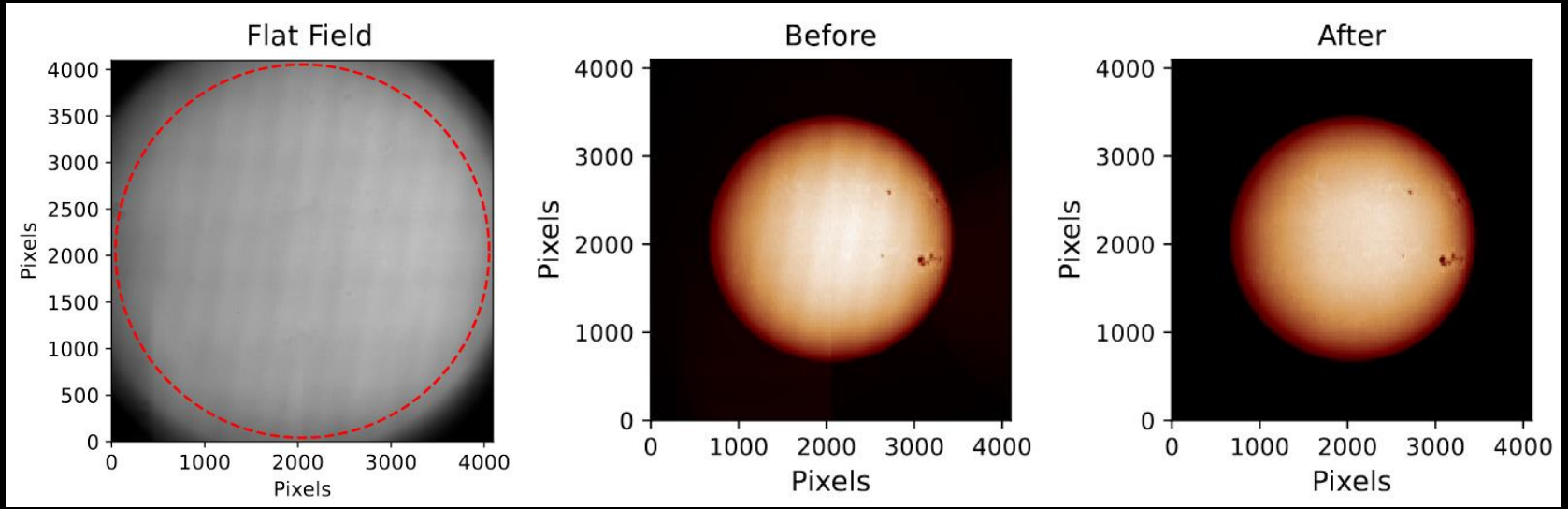
- Colorization
- Jitter correction for movies.
- Off-limb enhancement

Flat Field correction

- Generated from off pointed solar images.
- Stripe-like patterns are removed from SUIT images for all filters.
- Multiscale filtering is used to isolate the stripe like pattern.



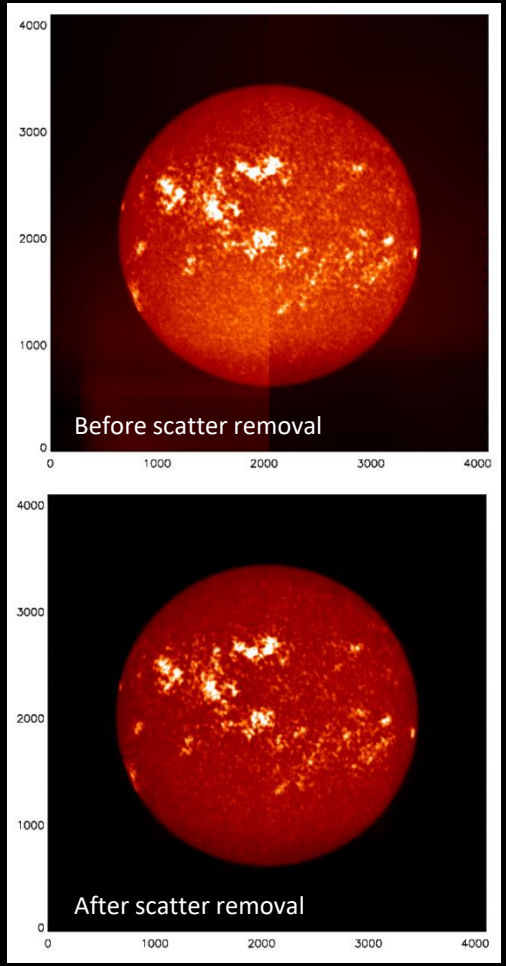
Off Pointing Scheme for SUIT



SUIT Flat Field correction applied to BB03 image

Scattered Light

Filter	Wavelength (nm)	Pre correction (%)	Post correction (%)
NB01	214	6.1	0.04
NB02	276.7	5.56	0.07
NB03	279.6	18.64	0.14
NB04	280.3	15.05	0.14
NB05	283.2	6.15	0.5
NB06	300	2.67	0.05
NB07	388	2.64	0.24
NB08	396.85	27.67	9.46
BB01	220	20.03	0.18
BB02	277	9.89	0.06
BB03	340	4.09	0.09

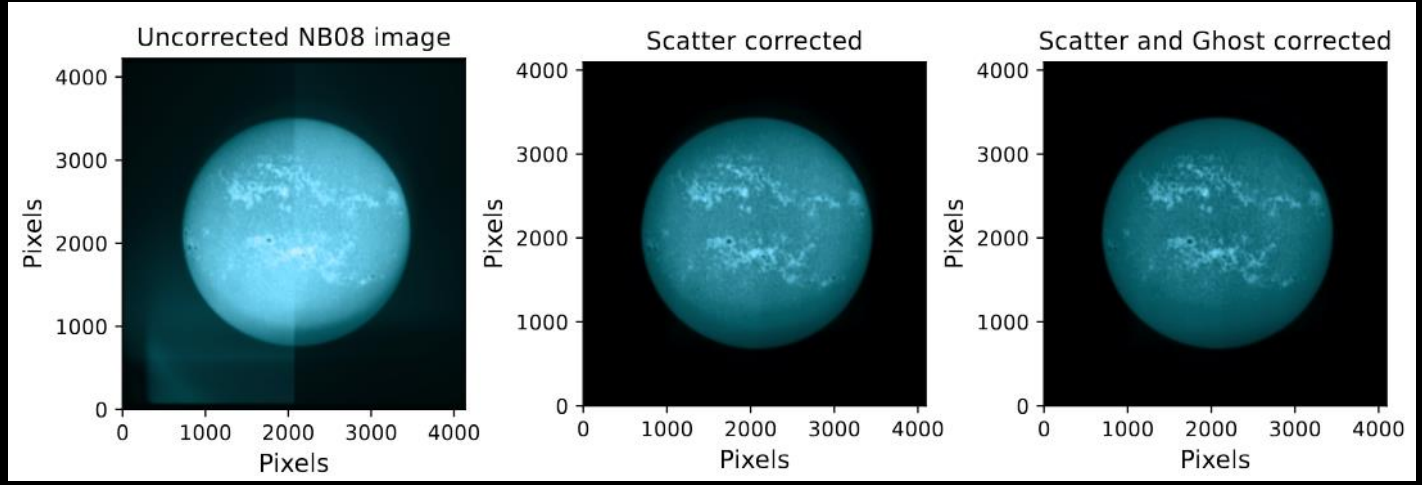


NB03 image before (top) and after (bottom) removing scattered light.

Credit: Nived V.N., IUCAA

Ghost Correction (NB08)

Filter	NB8 (396.85)
Uncorrected Image	27.67 %
Scatter Corrected	9.46 %
Ghost Corrected	1.67 %

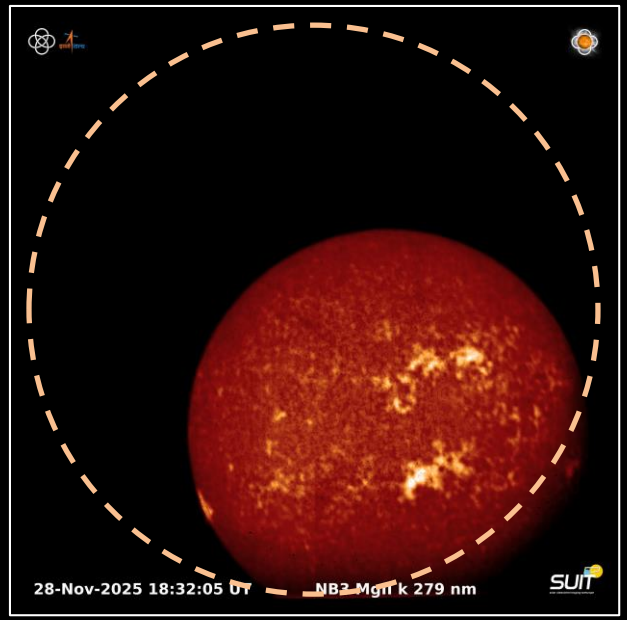


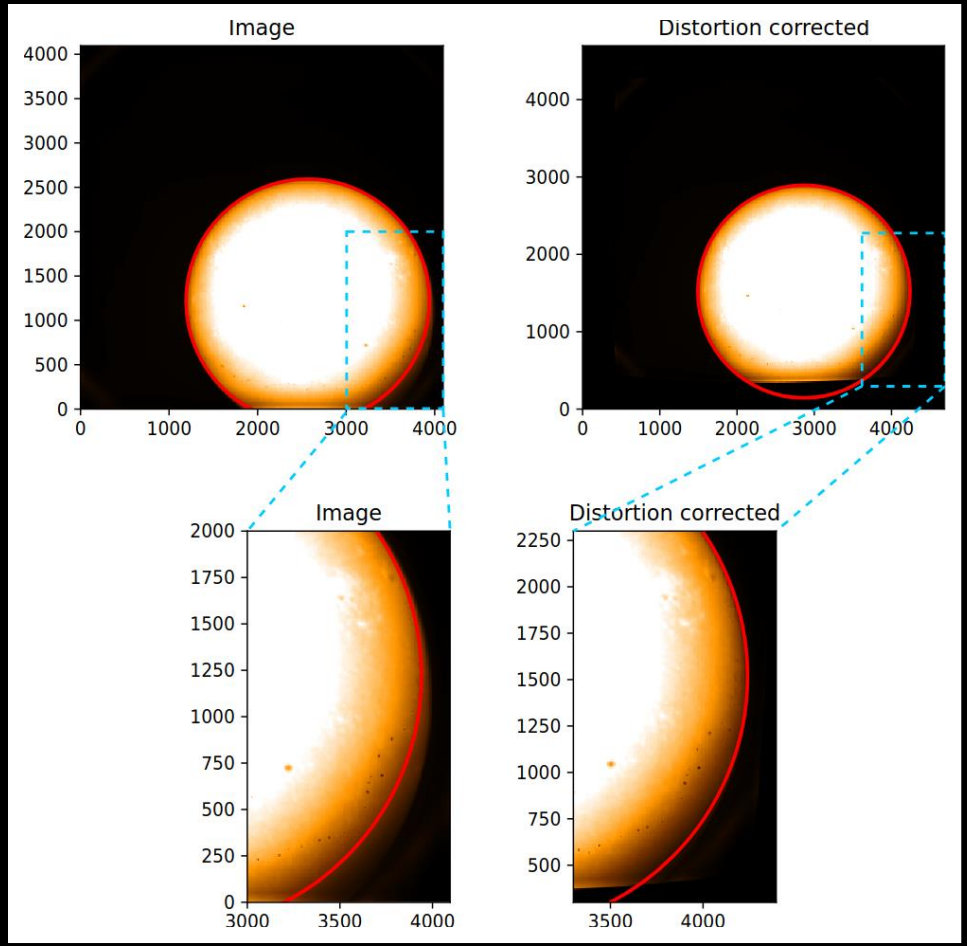
Scatter and Ghost removal of NB8 filter image.

Credit: Nived V.N., IUCAA

Distortion Correction

Level 2

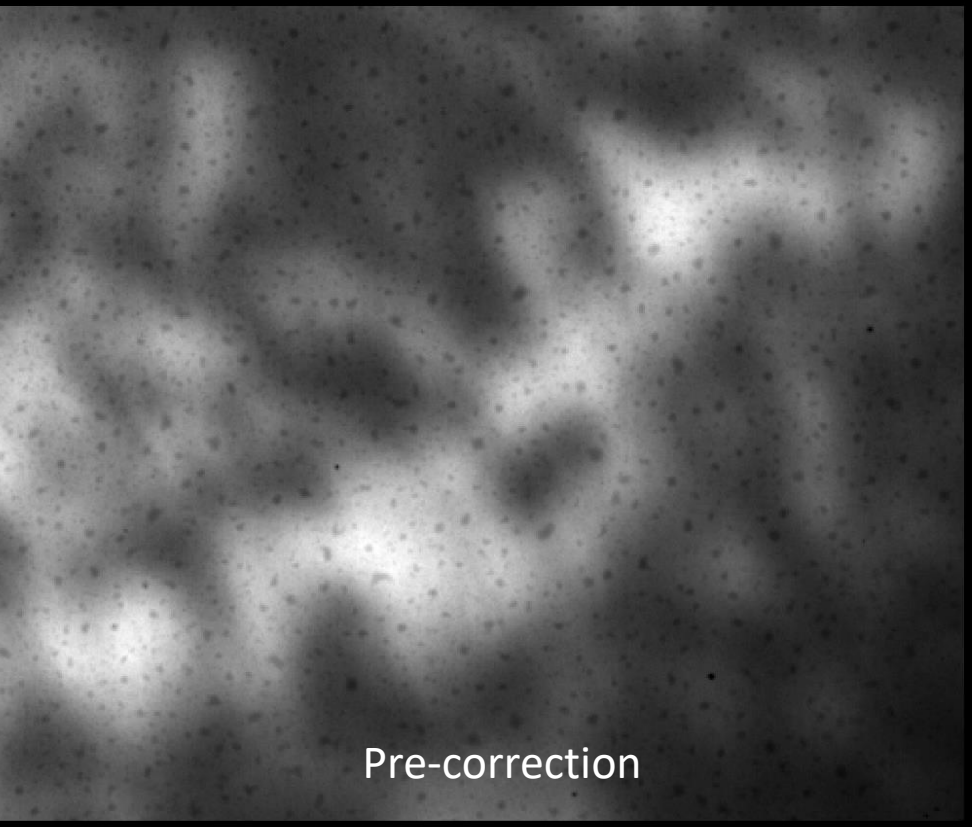


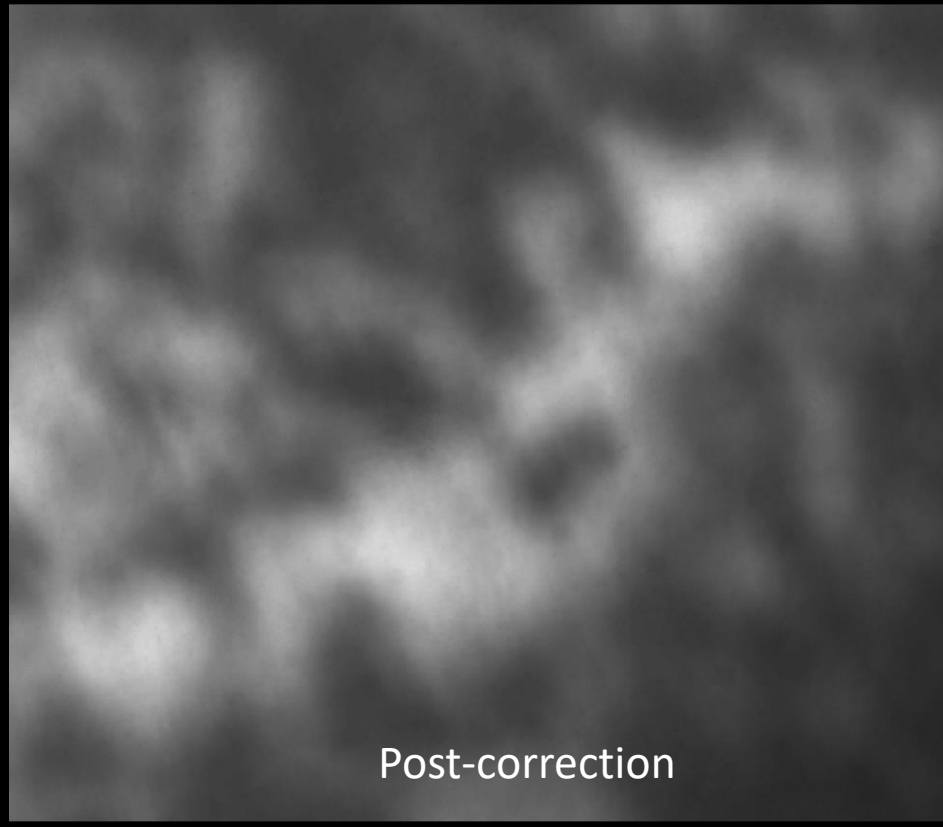


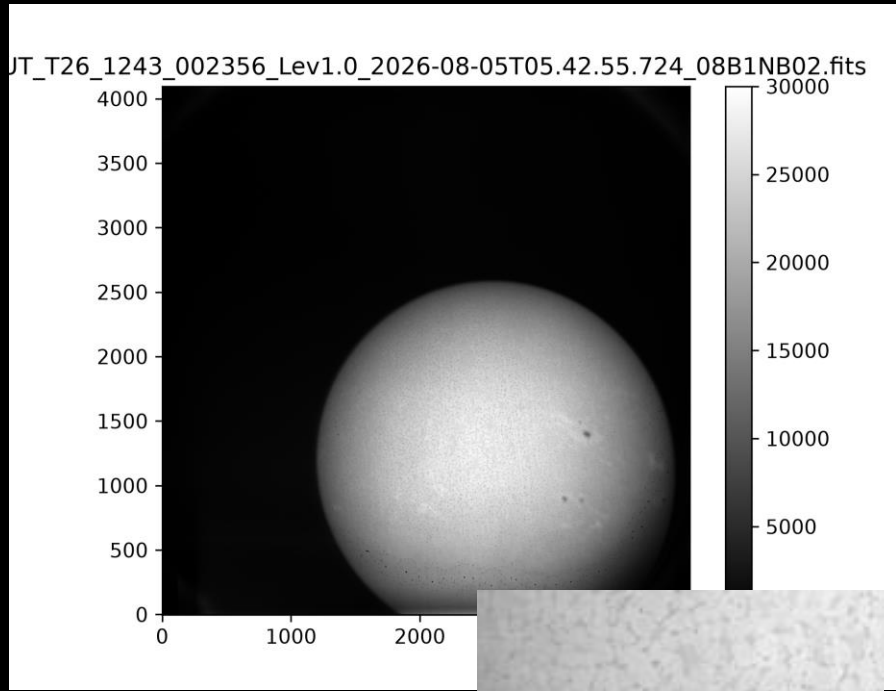
Distortion correction on SUIT image at VELC aligned position

Contamination removal

Level 2



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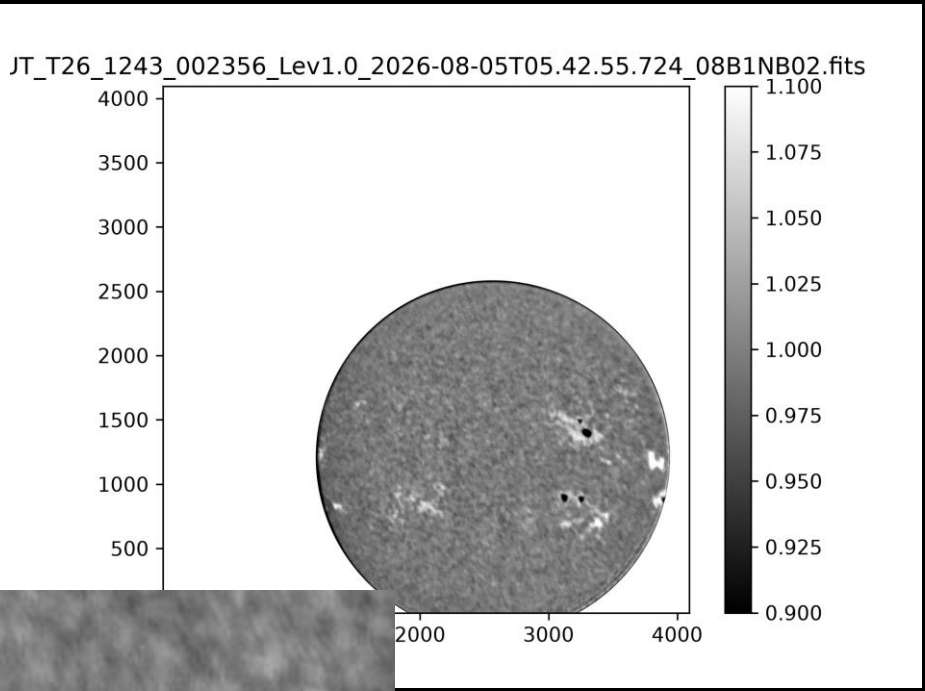
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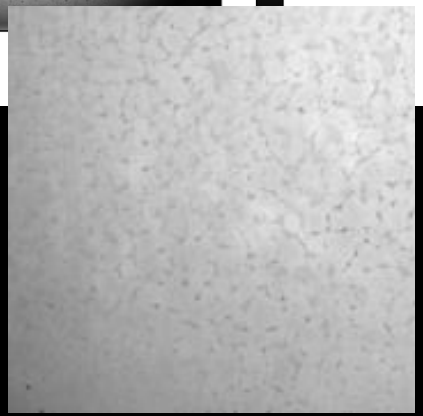
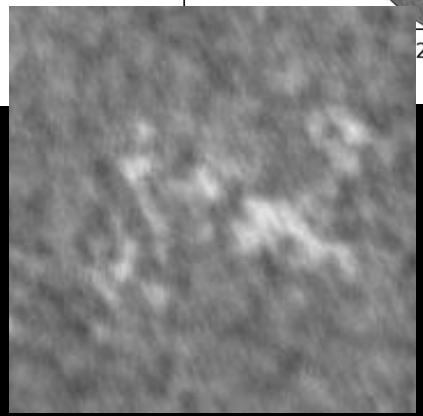


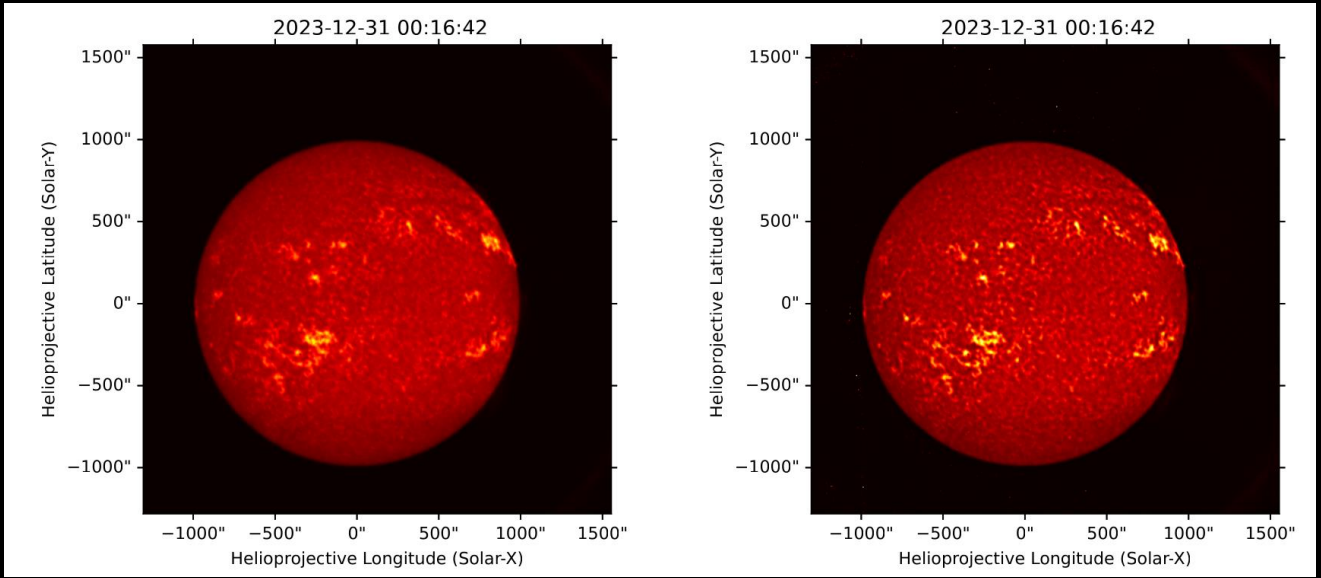


NB02 (276.7 nm)

Deconvolution

Level 2

- Lab measured PSF deconvolution: Ready
- On board PSF determination: In process

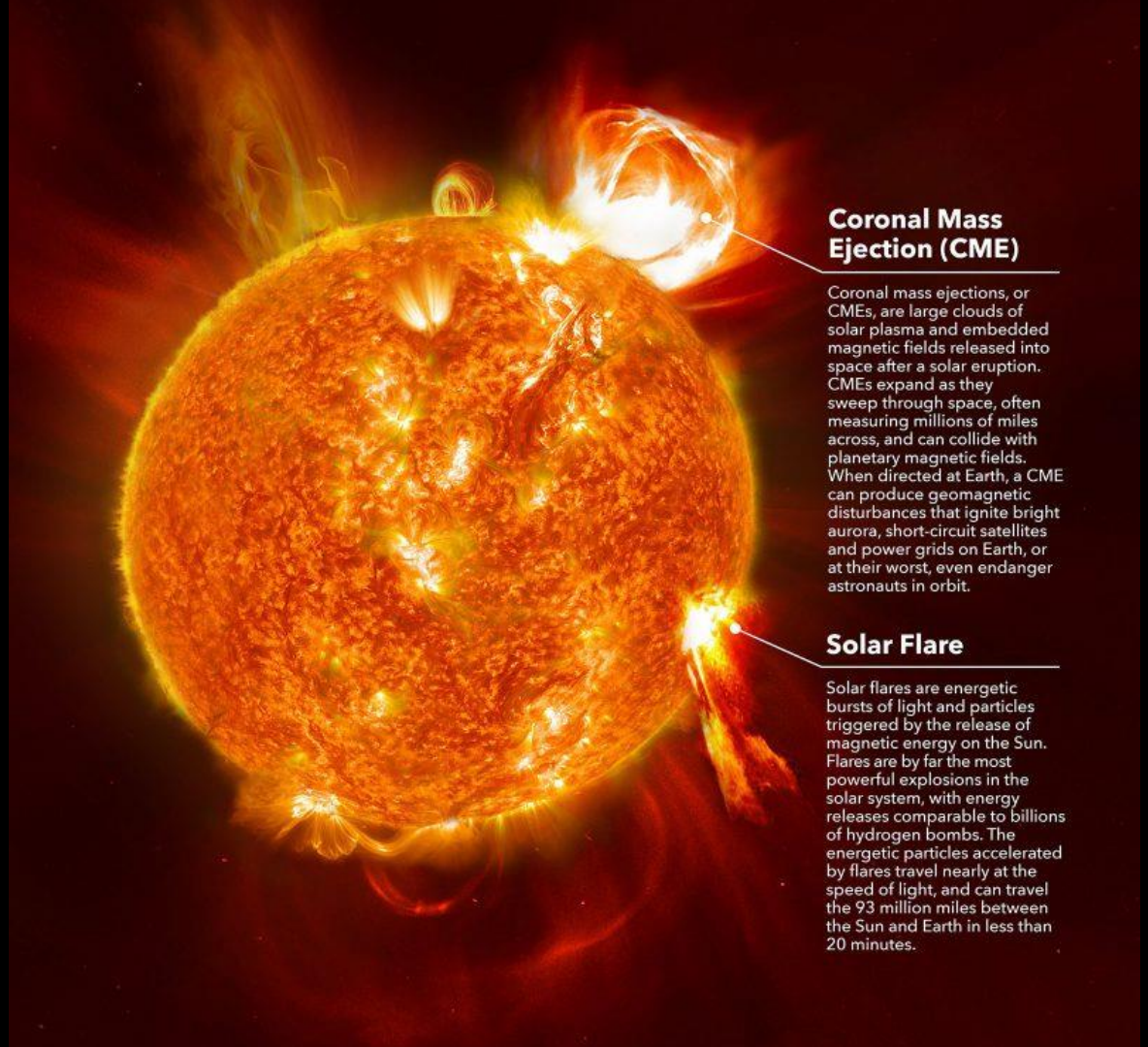


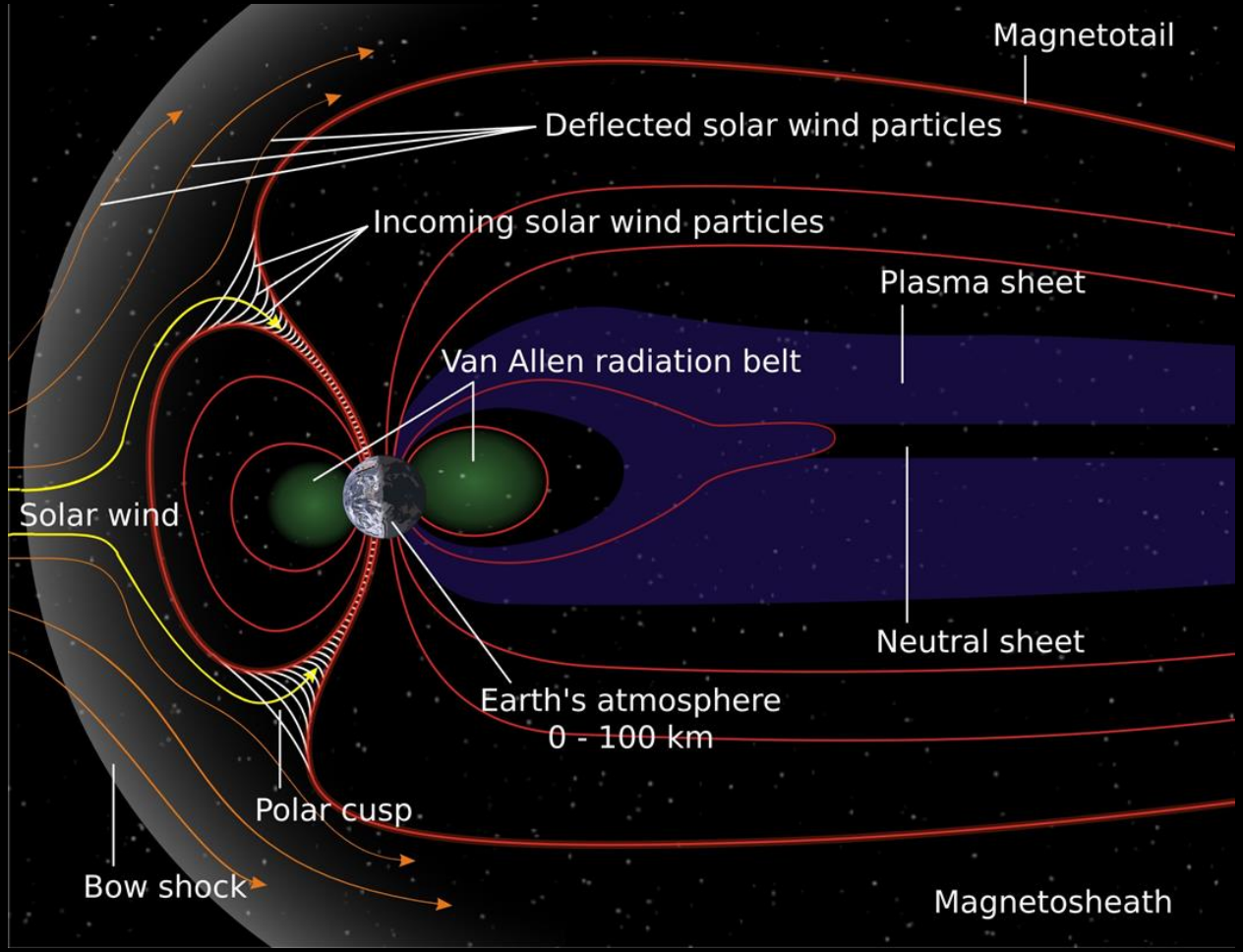
CORONAL MASS EJECTIONS & GEOMAGNETIC STORMS

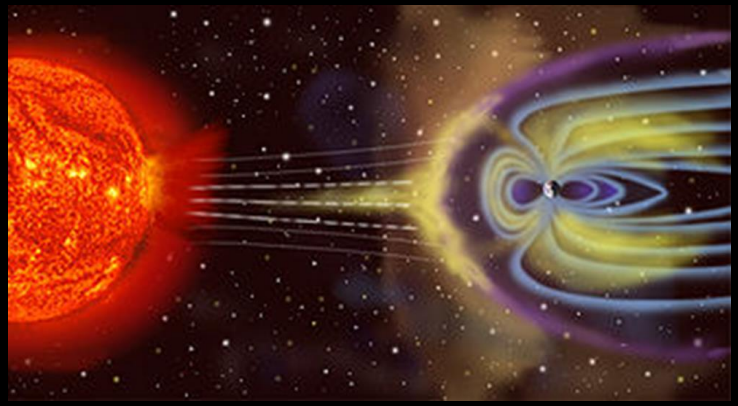
A **Coronal Mass Ejection (CME)** is a massive release of solar wind and magnetic fields from the **Sun's corona**. During a CME, large amounts of **charged particles** (such as electrons and protons) and plasma are ejected into space at extremely high speeds, often reaching millions of kilometres per hour. When a CME reaches Earth, it can interact with our magnetic field, leading to disturbances that can disrupt **satellite communications, GPS systems**, and **power grids**.

CMEs are caused by **magnetic activity** in the Sun's corona. The Sun's magnetic field is highly dynamic, constantly changing and shifting. These changes can cause the magnetic field lines to become twisted and stretched. When these magnetic fields suddenly realign or reconnect, they release a tremendous amount of energy, which pushes solar material outward into space, resulting in a CME. This explosive release of energy is often associated with solar flares, but CMEs may occur independently of them as well. The accurate connections between **CMEs** and **Solar flares** are still a scientific puzzle.

Understanding the causes and behavior of CMEs is crucial for predicting their effects on Earth and protecting our technology from space weather hazards.


Coronal Mass Ejection (CME)
Coronal mass ejections, or CMEs, are large clouds of solar plasma and embedded magnetic fields released into space after a solar eruption. CMEs expand as they sweep through space, often measuring millions of miles across, and can collide with planetary magnetic fields. When directed at Earth, a CME can produce geomagnetic disturbances that ignite bright aurora, short-circuit satellites and power grids on Earth, or at their worst, even endanger astronauts in orbit.
Solar Flare
Solar flares are energetic bursts of light and particles triggered by the release of magnetic energy on the Sun. Flares are by far the most powerful explosions in the solar system, with energy releases comparable to billions of hydrogen bombs. The energetic particles accelerated by flares travel nearly at the speed of light, and can travel the 93 million miles between the Sun and Earth in less than 20 minutes.


Magnetotail
Deflected solar wind particles
Incoming solar wind particles
Plasma sheet
Van Allen radiation belt
Solar wind
Neutral sheet
Earth's atmosphere
0 - 100 km
Polar cusp
Bow shock
Magnetosheath



March 1989 geomagnetic storm



Three CMEs from 8 May reached Earth on 10 May 2024, causing severe to extreme geomagnetic storms with bright and very long-lasting aurorae.

Conclusion

- Solar Ultraviolet Imaging Telescope (SUIT) is developed
  - L1 vantage point: 24x7 observation
  - Spatially resolved NUV full disk solar imaging
- Regular coordinated observations with IRIS, MAST/USO.
- SUIT Level 1 and Level 2 data are currently available for download from ISRO-PRADAN portal.
- SUITMap is supported in SunPy >7.0 package on Python.

REFERENCES

Papers:

1. Sarkar, Janmejoy, V. N. Nived, Soumya Roy, et al. 2025. “Test and Calibration of the Solar Ultraviolet Imaging Telescope (SUIT) on Board Aditya-L1.” Solar Physics 300 (5): 60. https://doi.org/10.1007/s11207-025-02468
2. Tripathi, Durgesh, A. N. Ramaprakash, Sreejith Padinhatteeri, et al. 2025. “The Solar Ultraviolet Imaging Telescope on Board Aditya-L1.” Solar Physics 300 (3): 30. https://doi.org/10.1007/s11207-025-02423-1

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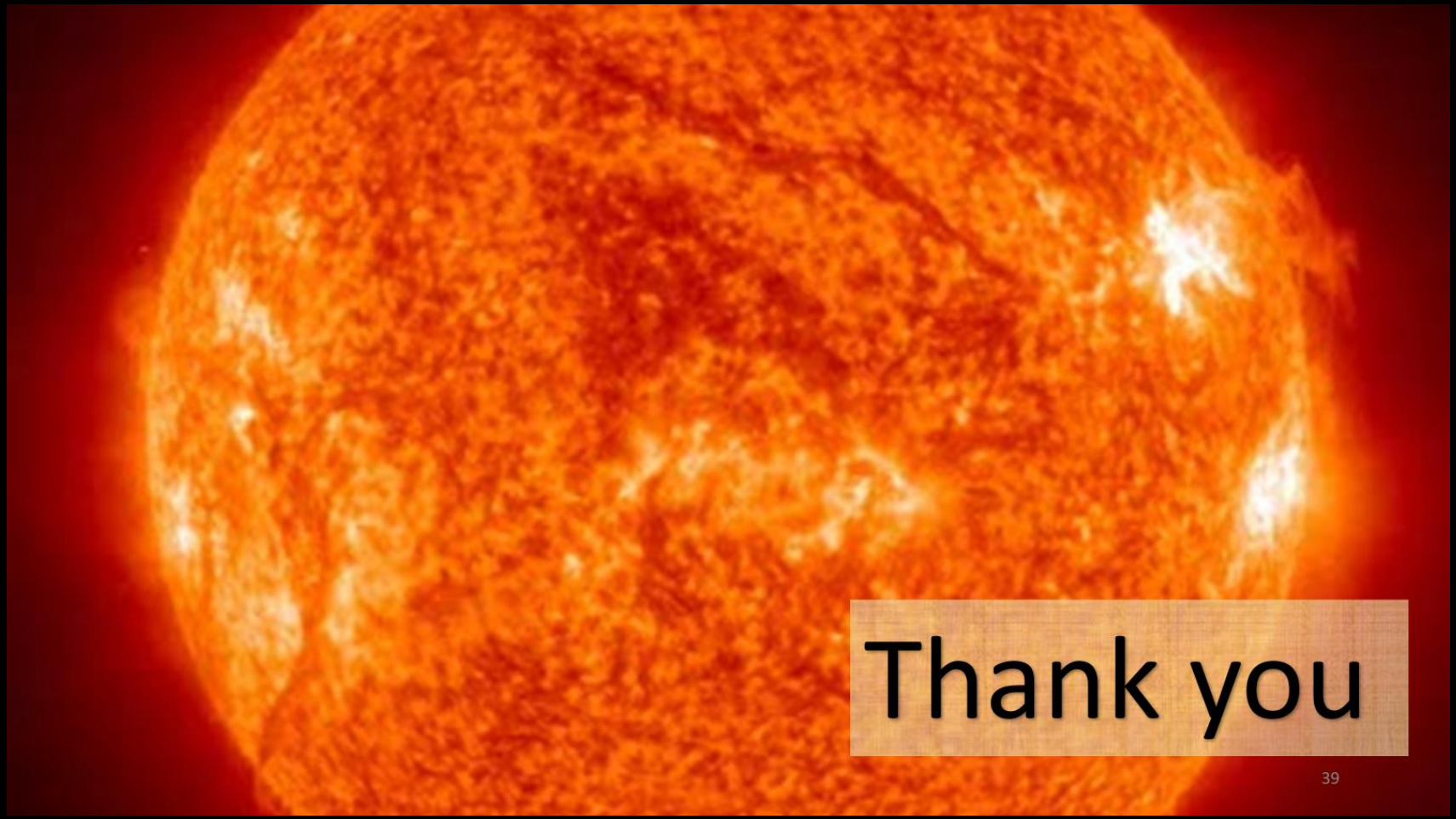
Thank you
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